

TABLE III.

Planet	U <sub>g</sub> in miles per second
Mercury	22.24
Venus	8.24
Mars	8.57
Asteroids	13.87
Jupiter	16.76
Saturn	17.68

Queen's College, Cork,  
1874, April 11.

*On a piece of Apparatus for carrying out M. Janssen's Method of Time-Photographic Observations of the Transit of Venus. By Warren De La Rue, D.C.L., F.R.S.*

(Described verbally at the Meeting of the 10th of April, 1874.)

It will be remembered that M. Janssen proposed to take advantage of the preparations which were being made for photographic observations of the transit of *Venus*, by adding thereto a special contrivance by means of which a series of photograms might be taken in rapid succession, when *Venus* had actually entered on the limb of the Sun. It was thus hoped to ensure a more exact time-record of the internal contacts of the planet and the limb of the Sun, than could be obtained by eye-observations.

The general scheme of the apparatus necessary to effect this object was well considered by M. Janssen, and there is little novelty in the form of the instrument I am about to describe; nevertheless, as there are some peculiarities in its construction, and as it contains the fewest possible number of moving parts, I have thought that it might not be unworthy of the notice of the meeting.

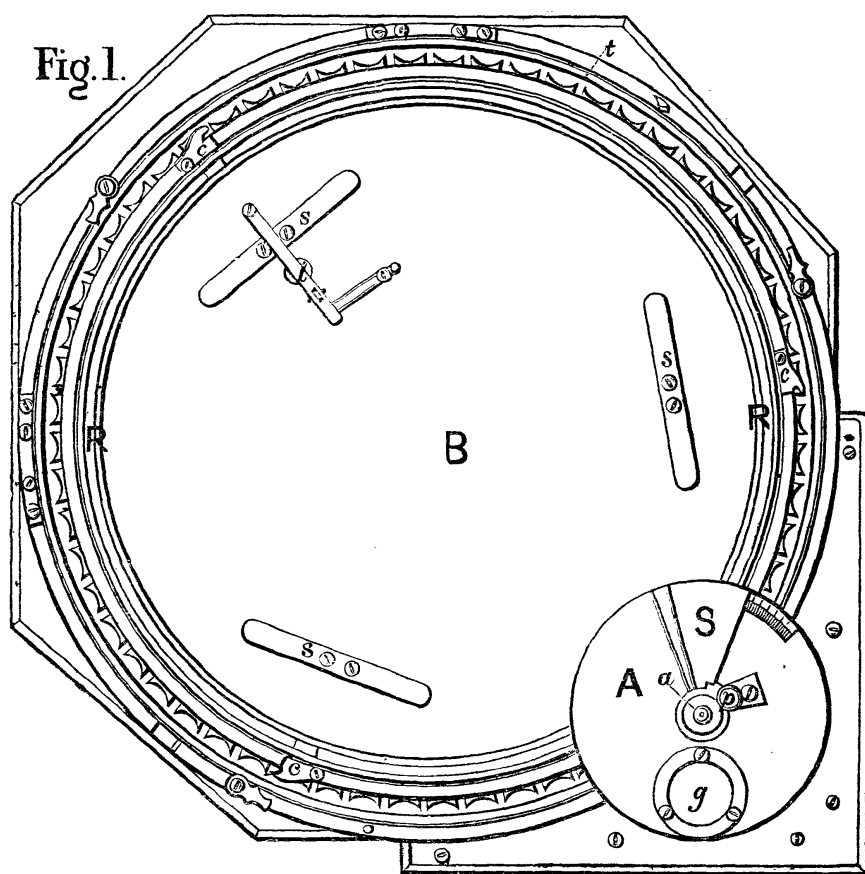
The photographic plate to be employed is supported in a cell which rotates on an axis excentric to the axis of the telescope;

in the cover of the fixed frame in which the cell rotates is a radial slit near the centre of the telescope and exposing a portion of the zone (one-sixtieth of its circumference); just above the cover of the plate-holder is a circular revolving shutter with an adjustable radial slit, the axis of this shutter is just beyond the periphery of the cell, and is therefore excentric to the cell; it carries a pin which falls into one of sixty radial slots racked in the edge of the plate-holder and carries it round one step for every revolution it makes. This axis, during each revolution, exposes one-sixtieth of the sensitive plate, then shuts off the light, and lastly brings a fresh portion of the film into position for the succeeding photograph.

Each time the instantaneous shutter exposes the plate contact is made with a wire from a voltaic battery and an electric circuit established with the electro-magnet of a chronograph.

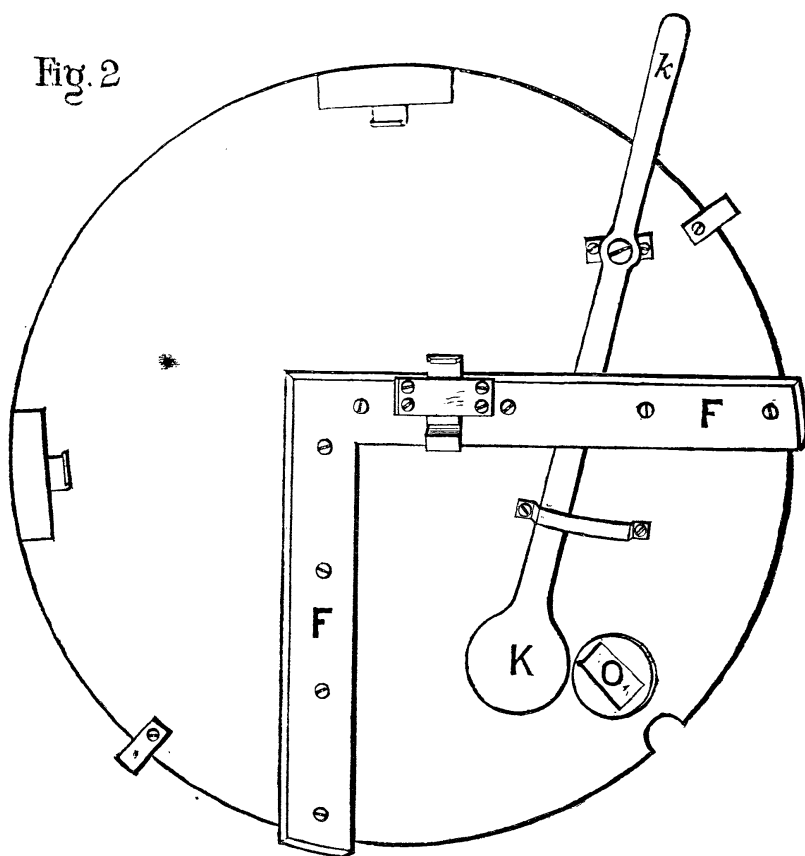
The sensitive plate to be used is a disk somewhat less than 11 inches in diameter; the fixed frame or casing is about 13 inches in its largest dimension and  $2\frac{1}{4}$  inches thick: the whole apparatus weighs twelve pounds and a quarter including the glass disk.

Fig. 1 shows that face of the apparatus which is turned towards the secondary magnifier when it is placed in the photo-heliograph; the cover, fig. 2, having been removed to show the several parts.



B, fig. 1, is the bottom plate of the circular cell which holds the glass disk; it is racked with 60 radial slots *t* and 60 circular spaces (these are shown in full size in fig. 4), *ccc* is a ring screwed to B to form the cell, it is electro-silver plated on the inside to prevent the nitrate of silver from acting upon it if wet plates are used. A removable ring R R, also electro-plated, serves to hold the glass disk in a plane at right angles to the axis of the telescope; it can be taken out to permit of the insertion of the glass disk after turning aside the catches *ccc*. The disk may then be dropped (the sensitive film uppermost) gently into its place on three pressure springs *sss*, and the ring R R pressed on it; the catches *ccc* when turned over the ring keep it exactly in its proper place, as they are bevelled at the edge and slide under

Fig. 2



dovetailed recesses in the rim of the cell. The cover shown in fig. 2 must then be placed over the plate and secured by the bolts and catches shown in fig. 1; the radial opening O must, of course, be covered by the shutter K before the apparatus is taken to the photoheliograph.

A, fig. 1, shows the instantaneous apparatus: it is a circular disk 4 inches in diameter, having a radial opening of about 1 inch at the periphery; the aperture is provided with a shutter by which

it may be completely closed, or the shutter may be opened to any extent by turning the pinion *p* which works into a portion of the shutter toothed for that purpose; the adjustment is facilitated by a graduated arc shown in the figure. On the opposite side there is inserted a disk of so-called ruby glass (copper-red) 1 inch in diameter; in a certain position of the cell this permits of the Sun's image being seen and adjusted to its proper place.

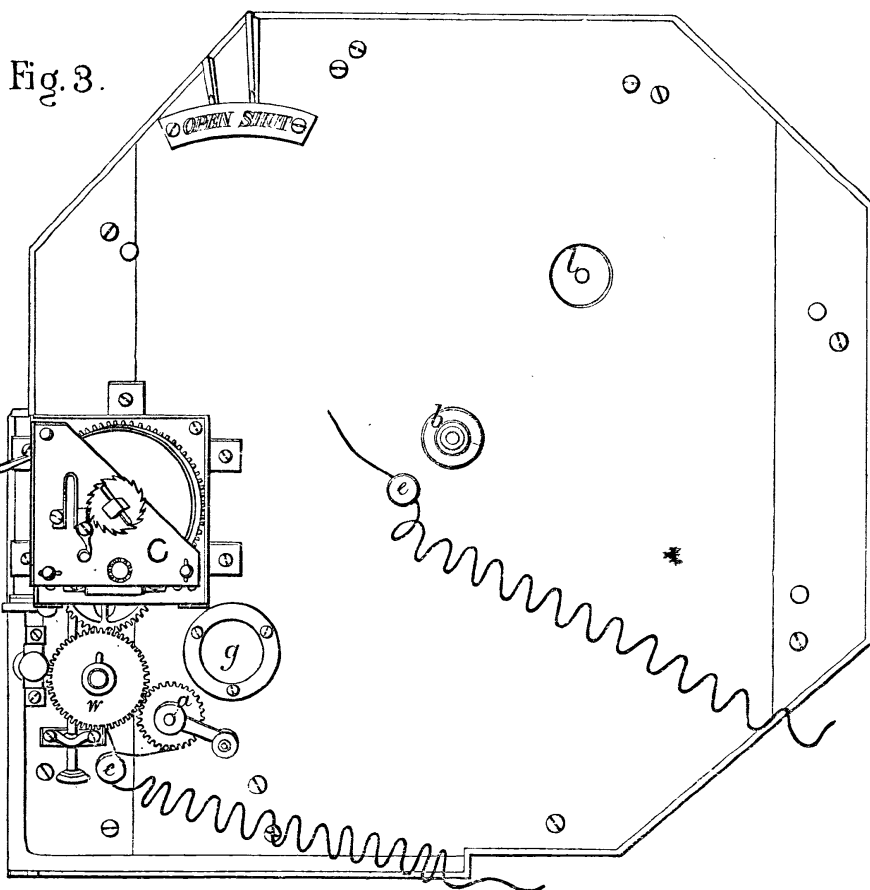


Fig. 3 represents the back of the apparatus; *b* is the axis of the plate-holder B; *a* is the axis of the instantaneous shutter; on it is fixed a toothed wheel to connect it with the clock-work driver, and also a handle to permit of its being turned by hand. *w* is an intermediate wheel always in gear with the wheel on *a*, but attached to an arm moving round *a* which permits of its being thrown in and out of gear with the driving-wheel of the clock C. In preparing the apparatus for work, *w* is thrown out of gear and the handle turned from left to right a sufficient number of revolutions to bring it to a stop, provided for that purpose; the stop is formed by racking the last of the slots *tt* for only a small distance.

The sensitive plate is now put into its cell, as before de-

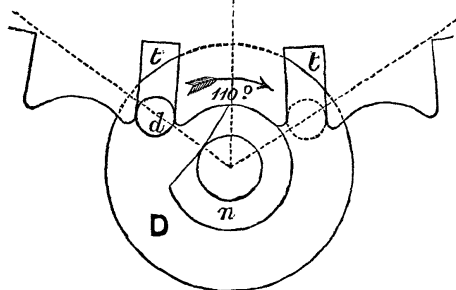
scribed, and the apparatus attached to the photoheliograph by means of the framework, FF fig. 2, fixed to the moveable cover; a screw-bolt in the photoheliograph fastens the framing firmly in its place. Attention having been paid to the directions given in the preceding paragraph, the aperture *g* covered with red glass will correspond exactly in position with similar red glass covered apertures in the instantaneous shutter and the bottom of the plate-holder B, and the Sun's image can be then seen and adjusted in position when the handle *k* of the shutter K has been set to the word "open."

The wheel *w* has then to be geared with the clock-driver C (previously wound up and stopped by a small detent, which acts against the fly governor). All being now ready, and the signal having been given, the detent, shown in fig. 3 on the left at the top of the clock-driver, is released with a slight touch of the finger and the apparatus starts and takes 60 successive photographs at any required interval; suppose at intervals of a second or of two seconds. A regulating pressure screw permits of the interval being varied within certain limits. After 60 photographs have been taken the apparatus stops because the pin *d*, fig. 4, enters the short slot.

On the axis *a* of the instantaneous shutter is fixed a disk of ivory in the periphery of which is inserted a platinum pin screwed into the pinion *a*; an insulated spring tipped with platinum presses against the edge of the ivory disk and completes the circuit of a voltaic battery connected with the chronograph at the exact instant that the slit in the shutter exposes a portion of the sensitive plate. Thus, even if the movement is not transmitted with perfect regularity, the precise epoch of each photograph will, nevertheless, be recorded.

It only now remains to describe the very simple mechanical contrivance by means of which a sixtieth part of the sensitive plate is successively brought into position under the radial

Fig. 4.

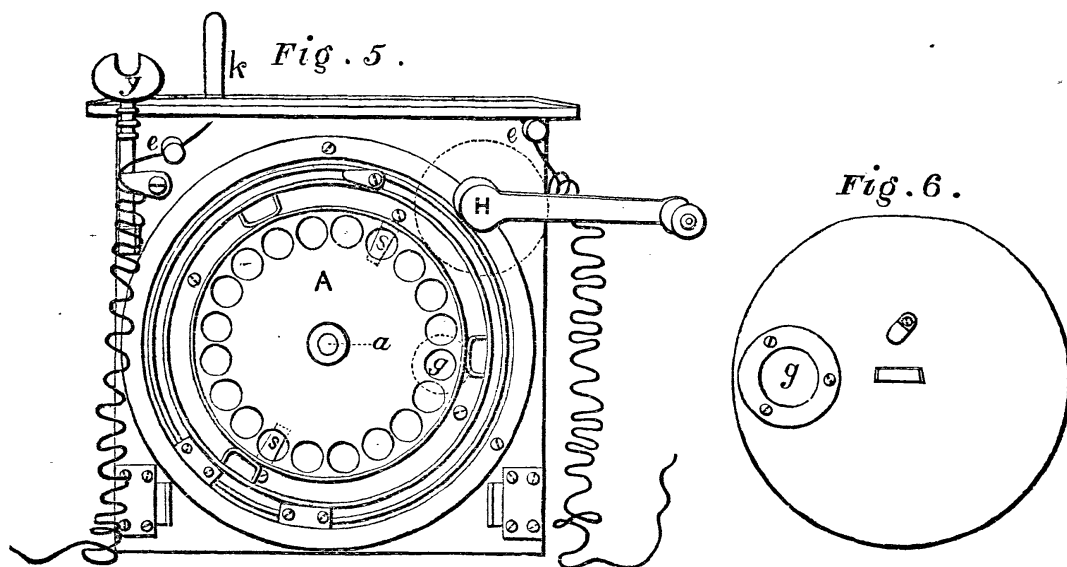


opening O, fig. 2, in the cover of the apparatus. Referring to fig. 4 drawn full size, D is a disk having a boss *n*, it is fixed on the axis *a* of the instantaneous shutter; in D is fixed a pin *d*

which, once in every revolution of the axis *a*, enters into one of the radial slots *t* of the plate-holder and carries it round one-sixtieth part of a revolution, reaching then the position shown by the dotted circle after having passed through an arc of  $110^\circ$ . Before it leaves the slot, the boss *n* has passed into one of the circular recesses corresponding to its own curvature, and locks the plate-holder firmly. In order to permit of the rotation of the plate-holder at the proper time, a portion of the boss *n* is cut away to a sufficient extent, as shown in the figure.

The apparatus just described has been fitted up for the Indian photoheliograph.

I may here state that Mr. Christie and M. Dallmeyer have contrived another form of apparatus also founded on M. Janssen's general proposition; and I will now describe another modification (verbally described at the meeting May 9th), which in reality is the one which I first devised. It was designed in order that it might exactly fall within the channels provided in the photoheliographs for the plate-holder to contain plates 6 in.  $\times$  6 in.; the conditions were more difficult to comply with than in the before-described plan, and the apparatus is conse-

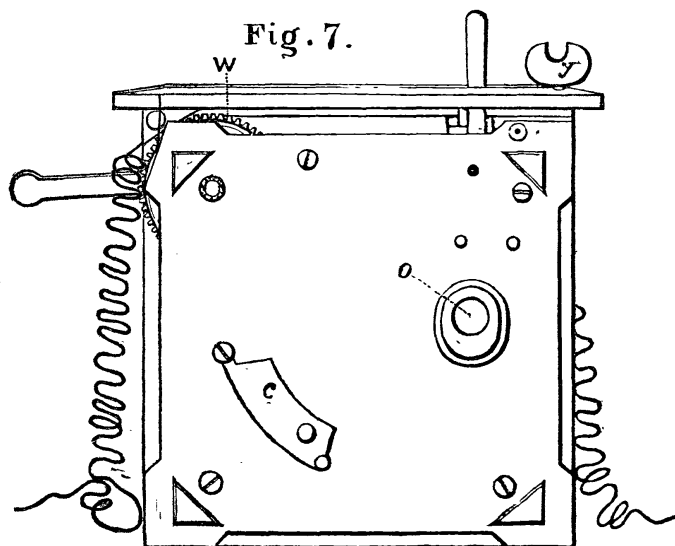


quently somewhat more complicated. Fig. 5 shows the back of the apparatus, that is the side turned away from the secondary magnifier. The cell *A* which holds the plate is perforated with twenty circular apertures through which the image of a portion of the Sun will be formed; it and the instantaneous apparatus rotate on the stud *a*; the sensitive film in this apparatus is placed downwards and rests on three bridle-wires of silver against which the plate is pressed by means of springs at the back of the cover fig. 6; the cover in this apparatus rotates with the cell to



which it is fastened by clips. There is a piece of red glass *g* inserted in it to permit of the Sun's image being seen; it corresponds in a certain position of the cell with similar pieces, one of which is inserted in the instantaneous shutter, the other in the shutter *k*.

The instantaneous shutter is concentric with the cell which holds the plates, and has two adjustable radial apertures *s s* Fig. 5,



which can be adjusted by means of the spanner *y*, after turning aside the door *c*; it is so geared with the wheel *W* on the axis of the handle *H*, fig. 7, that it makes half a revolution for one turn of the handle. On the axis of the handle is a pin which once in every revolution takes into one of the twenty epicycloidal teeth racked in the edge of the plate-holder, and between these teeth are circular locking recesses for a boss on the axis to enter and to lock the plate in position. *o* is an aperture which permits of the Sun's rays passing through one of the openings in the plate-holder.

To prepare the apparatus for work the handle *H* has to be turned from right to left a sufficient number of times to bring the driving-pin to the stop; the red glasses are then exactly one over the other. The handle must be turned in a contrary direction (left to right) to produce the photograms until after twenty pictures are obtained the pin again comes against the stop. There is a provision *ee* in the apparatus for electric communication with a chronograph. This particular apparatus is destined for the Melbourne Photoheliograph now in course of construction by M. Dallmeyer, as there is not sufficient time to provide one for sixty photograms.